The Efficacy of Mechanical Compression Devices in Cardiopulmonary Resuscitation

Emma A. French
Murray State University

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Table of Contents

Process

The Problem

Mechanical compression devices have become an increasingly popular tool for healthcare workers and paramedics to use in patients with cardiac arrest. The Lund University Cardiac Arrest System (LUCAS) is one of the most popular mechanical compression device among hospitals and ambulance systems. The LUCAS website discusses that the device eliminates healthcare worker fatigue and the need to switch compression providers every two minutes. The website also states, “LUCAS helps provide high-quality and safer chest compressions in situations such as patient movement and transportation, during prolonged CPR or in the cath lab” (LUCAS, n.d., “Why LUCAS,” para 2). While these are two great advantages to using mechanical compression devices, the most important aspect of these devices is how effective they are in performing CPR and if they are as effective as someone performing manual compression according to American Heart Association guidelines. The LUCAS website boasts clinical evidence that the device is safe and effective, however it is important for healthcare workers to review studies that compare these devices with manual compression in order to determine if one technique is better than the other, and if hospitals should implement the use of mechanical compression devices instead of manual CPR for the benefit of patients.

With any new medical device, extensive research needs to be done to determine the safety and benefit of the device for regular use with patients. Since mechanical compression devices are used frequently during patient transportation to hospitals and continued once patients arrive in the Emergency Department, it is imperative for hospitals and nursing staff to assess the research that has been done on these devices in order to follow evidence based practices and ensure good patient outcomes.

Current Policy and Outcomes

An important issue to observe with mechanical compression devices is the lack of hospital policy on the use of them. At both Lourdes Hospital in Paducah, Kentucky and Murray Calloway County Hospital in Murray, Kentucky, the nurse managers in the Emergency Department stated that while they do not use mechanical compression devices to initiate CPR in the hospital, if a patient is delivered by EMS with a device performing CPR, they continue CPR with the mechanical device during treatment at the hospital. However, upon review of CPR policies at both hospitals, neither policy included any details on the use of these mechanical compression devices in the hospital setting. All hospitals have very detailed policies of the procedures to follow during a code, who is in charge of what during a code, and ensuring that code carts are all stocked, checked frequently, and in the correct locations. Since the use of LUCAS device and other mechanical compression devices are not currently incorporated into regular healthcare worker CPR certifications, hospital policies specifying the use of these devices need to be developed if they are going to be used in patient care, at least until there are specific standards for use put in place by the American Heart Association or in healthcare CPR courses. Heart.org provides a recommendation for the use of mechanical compression devices.

> The evidence does not demonstrate a benefit with the use of mechanical piston devices for chest compressions versus manual chest compressions in patients with cardiac arrest. Manual chest compressions remain the standard of care for the treatment of cardiac arrest, but mechanical piston devices may be a reasonable alternative for use by properly trained personnel. (Heart.org, 2015, “Part 6: Alternative Techniques,” para 4.2.5.2)

Since mechanical compression devices are shown to be a reasonable alternative, but are not currently the standard of care for treatment of cardiac arrest, hospital policies dictating the

specific use of mechanical compression devices should be in place to protect the care of patients and the hospital and its staff. Further research comparing patient outcomes between mechanical and manual compression needs to be done to determine definitively if the standard of care for cardiac arrest should shift from manual compression to mechanical compression, but until then, if hospitals choose to use these devices policies need to be updated to include standards for their use.

Theoretical Framework

The theoretical framework used to dictate my research is Betty Neuman's Systems Model.

> Betty Neuman's Systems Model provides a comprehensive holistic and system-based approach to nursing that contains an element of flexibility. The theory focuses on the response of the patient system to actual or potential environmental stressors and the use of primary, secondary, and tertiary nursing prevention intervention for retention, attainment, and maintenance of patient system wellness. (Petiprin, 2016, "Systems Theory," para 1)

The aim of my research is not only to assess the success of mechanical compression devices in facilitating the return of ROSC in patients and effectively saving their lives, but also to assess the long term survival rate of patients. In resuscitation attempts, ROSC can occur, but brain function and future autonomy of these patients is not guaranteed. Ideally, in long term survival, the patient returns to or gets as close as possible to their original functioning. In this way, my research aims to assess the holistic outcomes of patients who were revived with mechanical compression devices and compare that to patients revived with manual compression. In Betty Neuman's Systems Model, "Secondary prevention occurs after the patient reacts to a stressor and is

provided in terms of the existing system. It focuses on preventing damage to the central core by strengthening the internal lines of resistance and removing the stressor" (Petiprin, 2016, "Systems Theory," para 4). Through examining the ability of mechanical compression devices in preventing further damage to patients while also successfully removing the problem of cardiac arrest, this research ties into Neuman's System Model and the specific aspect of secondary prevention. Focusing on the holistic health view set in place by Betty Neuman's theory has driven the purpose of this research and is the backbone to determining a conclusion on whether mechanical compression devices are more beneficial to patients than manual compression.

Evidence

Study 1

The first study I reviewed to determine the benefits of mechanical compression is called "The Efficacy of LUCAS in Prehospital Cardiac Arrest Scenarios: A Crossover Mannequin Study." This study is a randomized control trial which provides the highest strength of evidence (level 1). The researchers used a recording mannequin with CPR biophysical sensors to measure compression rate and depth. The mannequins were also weighted to simulate the weight of an actual patient. The mannequin was located on the second floor of a building approximately five miles from a medical center and was programmed to present in ventricular fibrillation. 13 crews that included one paramedic and one EMT were assembled to participate in the trial. The crew was instructed to go through the state-delineated protocol for cardiac arrest response and transport the mannequin from the building to the medical center. Each team performed CPR to a mannequin in the same setting and situation two times, once using the LUCAS device to perform compressions and once using manual chest compressions. The researchers then reviewed the data collected by the recording mannequins. The results showed that "LUCAS had a lower median number of compressions per minute (112/min vs. 125/min), which was more consistent with

current American Heart Association CPR guidelines, and percent adequate compression rate (71% vs. 40%). In addition, LUCAS had a higher percent adequate depth (52% vs. 36%) and lower percent total hands-off time (15% vs. 20%)" (Gyory, R. A., et al, 2017). The researchers concluded that "LUCAS had a higher rate of adequate compressions and decreased total hands off time as compared to manual CPR" (Gyory, R. A., et al, 2017). The researchers also made an important statement in their conclusion.

> There are data showing that LUCAS is very effective in prehospital cardiac arrest and patient outcomes and that the device is safe for patient use and does not lead to undue patient injury. However, not enough data on real patients exist; thus, this area is clearly ripe for future work. (Gyory, R. A., et al, 2017)

Using the JHNEBP Research Evidence Appraisal guidelines, I determined that the quality of this evidence was good. The way the researchers illustrated the sample size could have been better approached, however with limitations to real patient studies on this topic, I believe this study was conducted very effectively and demonstrated an important finding of mechanical compression devices: that they can deliver a compression rate and depth that is more consistent with American Heart Association guidelines than manual compression can. It also demonstrated the benefits of the use of these devices in transportation, and the ability to continue compressions in situations where manual compressions would need to be stopped.

Study 2

The next study I reviewed was called "Mechanical chest compression devices at in-hospital cardiac arrest: A systematic review and meta-analysis." This study is a meta-analysis, which is also the highest strength of evidence (level 1). This study summarizes evidence from six studies done on the use of mechanical compression devices during resuscitation from in-hospital

cardiac arrest. The studies that were reviewed examined short term and long term survival with good neurological outcomes of patients revived with mechanical chest compressions compared with manual chest compressions. The results of the analysis showed “an association between use of mechanical chest compression device and improved hospital or 30-day survival and short-term survival. There was also evidence of improvements in physiological outcomes” (Couper, K., et al, 2016). The meta-analysis concluded that “Mechanical chest compression devices may improve patient outcome, when used at in-hospital cardiac arrest. However, the quality of current evidence is very low. There is a need for randomised trials to evaluate the effect of mechanical chest compression devices on survival for in-hospital cardiac arrest” (Couper, K., et al, 2016).

This study is the most important one for the purpose of this topic. Since it is a meta-analysis, it reviewed multiple studies that have already been done on mechanical chest compression devices and formed a conclusion based on those studies. This was a high quality analysis which concluded that mechanical compression devices can improve outcomes when compared to manual compression in the hospital, and it also pointed out the important aspect of the urgent need for more research on these devices in real patients.

Study 3

The third study I reviewed focused more on pre-hospital care with mechanical compression devices. “Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): A pragmatic, cluster randomised control trial” examined out-of-hospital cardiac arrest treatments from four different ambulance services in the United Kingdom. Ambulances were randomly assigned to use LUCAS devices or manual CPR, and patients received either treatment based on the first vehicle to arrive on the scene. 4471 patients were enrolled in the trial after receiving either intervention by one of the four ambulance services. The

results showed that 30-day survival was similar in the LUCAS group and the manual CPR group. The researchers concluded that there was "no evidence of improvement in 30-day survival with the LUCAS device compared with manual compressions. On the basis of ours and other recent randomised trials, widespread adoption of mechanical CPR devices for routine use does not improve survival" (Perkins, G. D., et al, 2015).

This study was a randomized controlled trial which provides the highest level of evidence. I determined that the quality of the evidence in this study was good and that there were many limitations to this study. One important limitation was that the study points out that slightly more patients received adrenaline after randomization in the LUCAS group than in the manual CPR group, which may increase cardiac instability and impair cerebral microcirculation (Perkins, G. D., et al, 2015). With external variables such as different treatment methods, this further points out how hard performing accurate trials are involving these devices and how hard it is to maintain controls. This study is important to include in this project because it shows that improved survival is not yet seen in mechanical compression devices and proves the point that further research still needs to be done on this topic.

Proposed Policy

The current CPR policy at Murray Calloway County Hospital covers various steps to take when initiating a code in the hospital and performing CPR. The aspect of the currently policy that is of the most interest is section F. "BLS certified personnel: 1. Will need to be available to perform chest compressions; this could be anyone with their BLS certification" (CPR Committee, 2019, "Responding to codes," para. F). With the implementation of mechanical compression devices in the hospital, an addition to this policy would need to be made. The addition I am proposing would be a new paragraph in the "Responding to Codes in the hospital

and hospital operated departments" section. A new section G would be inserted after this and would state "BLS certified and Mechanical Compression Device Trained Personnel: 1. Will need to be available to initiate the use of the approved mechanical compression devices and supervise the use of the device throughout the code." This addition would be in accordance with the Heart.org recommendation that devices can be used in place of manual compression. This would also ensure that only trained personnel would be authorized to set up the device and monitor it's use to ensure patient safety and proper operation.

In the future, mechanical compression devices may be incorporated into basic life support training courses, and a BLS certification could include the operation of mechanical compression devices. In this case, the policy discussed previously could be updated to under section F to say "BLS certified personnel: 1. Will need to be available to perform chest compressions or initiate the use of the mechanical compression device; this could be anyone with their BLS certification." This addition would only be possible if the use of mechanical compression devices is included in BLS training in the future, but would cover all of the necessary aspects to safely use these devices.

The addition of a new section in the CPR policy at Murray Calloway County Hospital will allow the hospital to cover all of their bases and ensure the safe operation of mechanical compression devices.

Implementation into Professional Practice

For this policy change to be implemented into practice, nurses would need to be educated about the updated policy. Nurses would be required to participate in training to learn how to use mechanical compression devices in order to be able to use them in their practice. The hospital would determine the preferred device they would like to use in their facility and training classes

can be provided to staff that wish to participate. By holding training classes in a voluntary manner, staff that wish to use the device can decide for themselves if they would like to implement it into their practice, or if they would like to stick with manual compression during CPR. By presenting the research on mechanical compression devices and allowing for staff to determine for themselves if they would like to be trained, this encourages autonomy and also does not force staff into changing to a new way of performing CPR if they do not feel comfortable with changing to that method. Since there is not enough research yet to definitely determine that mechanical compression devices provide better patient outcomes, this allows the hospital to be in line with the current recommendations that manual compressions are still the standard, but mechanical compression devices are a safe alternative that can be used at the hospital's discretion. Compliance with the new policy change would be assessed by only allowing personnel who are BLS certified and trained in using mechanical compression devices to use the device, and assessing during and after codes if this policy was followed.

Conclusion

Mechanical compression devices have been shown to be safe for use in patients and can provide a more accurate rate and depth of compression when compared to manual compression. There is also evidence that mechanical compression devices can improve in-hospital and 30-day survival rates of patients who were treated with these devices for cardiac arrest. In addition to these patient benefits, mechanical compression devices can eliminate the need for resuscitators to switch during compressions and prevent fatigue associated with performing CPR. They can also allow compressions to continue during transportation of patients to ensure adequate perfusion is not interrupted. Finally, these devices can allow for more trained personnel to help in other

aspects of patient care during cardiac arrest and does not require an additional person to perform continuous manual compressions.

While more research needs to be done to determine definitively if mechanical compression devices are better than manual CPR, I can conclude that these devices allow for easier transportation of patients, and that the evidence currently points to better patient outcomes when used instead of manual compression. Mechanical compression devices should be considered for adoption into regular nursing practice and have been shown to provide numerous benefits for healthcare workers and patients.

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Copy of Policy

Policy Title:

Cardiopulmonary Resuscitation

Policy Statement:

American Heart Association Basic Life Support measures will be initiated immediately for any person who is found to be in acute cardiopulmonary distress or arrest in one of MCCH clinics, hospital, or other clinically staffed facilities, unless there is evidence of a Do-Not-Resuscitate Status.

I. Code Locations and Calling a Code

A. In the event that an individual, who may include a patient, visitor, or staff may experience the need for cardiopulmonary resuscitation or any emergent medical attention, initiate the code based on the location on campus or off campus locations.

B. If in the hospital: Call the hospital operator by dialing 0 or dial 8210 to page overhead the location and the room number and area in the hospital; repeat this at least 3 times.

C. If the area is not on the main campus such as the Medical Arts Building East, West, or the Wellness Center, or Spring Creek, dial 911 for the ambulance service.

D. Hospital operated outpatient departments that are located in the Medical Arts Building will call a Code Blue by calling the hospital operator, or dialing 8210 and paging the location overhead, as well as calling 911 for the ambulance. These departments include, but are not limited to Sleep Lab, Cardio and Pulmonary Rehab, and Occupational Medicine.

E. It will be at the discretion of the ED and Surgery Department's staff and charge nurses to determine if a Code Blue announcement is made in their respective departments.

II. Responding to Codes in the hospital and hospital operated departments: A. CCU Nurse:

1. Will respond to every code and will act as the code leader until a physician arrives 2. Assign roles
3. Remain on scene to fill any role required after a physician arrives.

B. Respiratory Therapist:

1. Will respond to every code to protect and maintain airway
2. Assist with compressions.

C. Nursing Supervisor/Director:

1. Will bring the exchange cart from the Code Cart Corral to the unit/department.
2. Move the defibrillator to the new cart to maintain consistency of defibrillators within the unit.
3. Transfer notebook containing all forms to the new cart.
4. Delivers the used cart to Materials Management to begin restocking process.
5. Assures used cart is cleaned
6. Reviews the Cardiopulmonary Resuscitation Event Record for completeness and accuracy, makes additional comments if needed.

D. Charge nurse of the unit:

1. Will respond to every code to ensure accurate and complete documentation of code events.
2. Assures all nursing tasks are completed and documented including printing and placing rhythm strips on patient chart.
3. Designates a staff nurse to clean the cart and discards used supplies per exposure control guidelines.
4. Ensures a patient label is affixed to each copy of the Cardiopulmonary Resuscitation Event Record, assuring patient's account and room is documented on each page.
5. Places white copy of the record on the patient chart; the pink and yellow copy is placed on top of the used cart to go to Materials Management.

E. The patient's nurse:

1. Will respond to the code to notify patient's physician and give a history of patient to code team.

F. BLS certified personnel :

1. Will need to be available to perform chest compressions; this could be anyone with their BLS certification

G. The Code Recorder:

1. Will be responsible for filling out the Cardiopulmonary Resuscitation Event Record.

2. Filling out the Cardiopulmonary Resuscitation Event Record includes: Times when key code activities occurred, interventions that were provided, and other pertinent information.

H. The primary code physician will be responsible for signing the patient's resuscitation flow sheet.

V. Code Carts

Code carts are universal, containing supplies for both adult and pediatric patients. It may be used to provide materials in any patient emergency. For a complete list of supplies used in the Code Cart, see C-003A1 Attachment- Code Cart Inventory Checklist. For a complete list of drugs on the Code Cart, see C-003A2; for a list of code cart locations, see C-003A3.

A. Integrity and Readiness of the code cart:

1. Code Carts are locked with a numbered, breakaway lock and are in a constant state of readiness. In order for a location to always have a code cart available, there will be additional code carts in storage ready to be used in an exchange system. If all back up carts are used, Materials Management and/or Pharmacy will be called in to restock the carts.

2. Materials Management, Nursing Supervisor, Pharmacy, and Department Directors can retain keys to this room.

3. Materials Management Department ensures that supplies on the carts are restocked and indate.

4. The Pharmacy Department ensures that drugs on the carts are restocked and in-date.

5. An expiration date sticker denoting the earliest date of expiration for both Materials Management items and medications will be affixed on the top/front of each code cart. The breakaway lock number will also be written on this sticker to ensure the cart's integrity.

6. Unit staff will check the expiration sticker and breakaway lock number and integrity on a daily basis when the defibrillator check is done. For departments that are not operational on an everyday basis, checks will be done every day the department is open.

7. Unit staff will also check oxygen availability on their carts; this includes maintaining a psi above the red line indicator on the pressure gauge.

8. If the lock has been broken on a code cart or if the lock does not match the number on the expiration sticker, they should notify the charge nurse/nursing supervisor, or secure a new code cart from the corral to replace the compromised cart; then, take the compromised cart to the corral to be checked and restocked. This process is to ensure that there is a code cart ready at all times in the unit.

9. The red break away locks are kept by pharmacy and ordered only by pharmacy.

10. If the Code Cart expiration sticker date is out of date or close to being out of date, notify the charge nurse/nursing supervisor, or secure a new code cart from the corral to replace the compromised cart; then, take the compromised cart to the corral to be checked and restocked. This process is to ensure that there is a code cart ready at all times in the unit.

11. If the oxygen tank needs to be changed out on a used Code Cart due to a low content or is missing from the Code Cart, a new oxygen tank can be retrieved from the oxygen storage room located on the 1st floor of the South Tower. Materials Management or Pharmacy can call Respiratory Therapy to obtain a new tank for carts that are being restocked after use.

12. All additions, deletions and/or revisions to the code cart contents must be reviewed and approved by the CPR committee. Any major changes identified by the CPR committee must be approved by the Medical Executive Committee.

13. When a variation or non-compliance occurs in any aspect of the code cart readiness or replenishment process, the variation is documented as an event in the hospital approved reporting system. Such variations may include the used code cart not being appropriately cleaned before transfer, code cart not being checked routinely. The event report will be forwarded through the appropriate channels for information gathering and trending to determine the need for further action.

14. There is a Broselow Cart located in the Emergency Department in the event of a Pediatric Code.

15. There are three Broselow Bags located on 4 south, Surgery, and CCU in the event of a Pediatric Code.

APPROVALS:

_____ _____

CPR Committee Chairperson Date

_____ _____

Provision of Care Chairperson Date

_____ _____

VP Patient Care Date

Original: 4/1976
Reviewed: 8/1980, 4/1981, 12/1989, 9/1992
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